



# SERIES 2000 / 3020

ANALOG TEMPERATURE  
CONTROLLERS

*Instruction  
Manual*





## Introduction

Congratulations on your purchase of an Athena® Series 2000 or Series 3020 analog temperature controller. It is a U.L. listed, 1/4-DIN controller for use in a variety of applications. Standard features include time proportioning with auto-adjusting cycle time, djustable bandwidth (for on-off to wide band proportioning), and offset (manual reset). Outputs include relay, triac, or mAdc types.

If you have questions or require any assistance with your controller or with any temperature control problem, please contact your Athena representative or call technical support at 1-800-782-6776. Outside the USA, please call 610-828-2490.

## Precautions

After unpacking, inspect the instrument for any physical damage that may have occurred in shipping. Save all packing materials and report any damage to the carrier immediately.

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## Output Configurations

Type "B"	Relay with 7 A at 120 V and 5 A at 240 V contacts, on-off and time proportioning
Type "F"	Signal current, 4-20 mA <sub>dc</sub>
Type "L"	Relay with 7 A at 120 V and 5 A at 240 V contacts, on-off, reset switch
Type "T"	Solid state relay 1 A, 120/240 V resistive load; 1 A, 120/240 V, 10 A inrush, inductive load (not U.L. rated)
Type "S"	Pulsed 20 V <sub>dc</sub> , for driving solid state relays

## Preliminary Instructions

### Unpacking

Carefully unpack the instrument, inspect for shipping damage. Report any damage to the carrier immediately.

### Locating

Select a location for the controller where it will not be subjected to excessive shock, vibration, dirt, moisture or oil. The ambient temperature of the area should be between 30° and 130° F. (Dust, oil, water resistant cover is available to protect from harsh environments. Contact factory for details.)

## Mounting

### Mounting

Mount controller into 92 mm (3-5/8") square cutout (1/4-DIN). See Figure 1 for cutout and case dimensions. The plug-in controller does not have to be removed from its housing for mounting.

Remove the two screws in the back of the case that hold the mounting slides, and then remove the slides. Insert case from front of panel and reinstall the two slides and two screws. The length of the slides must be reduced if the controller is to be mounted in an extra thick panel. If the controller has been unplugged from its housing, the top of the housing can be determined by the serial number tag.

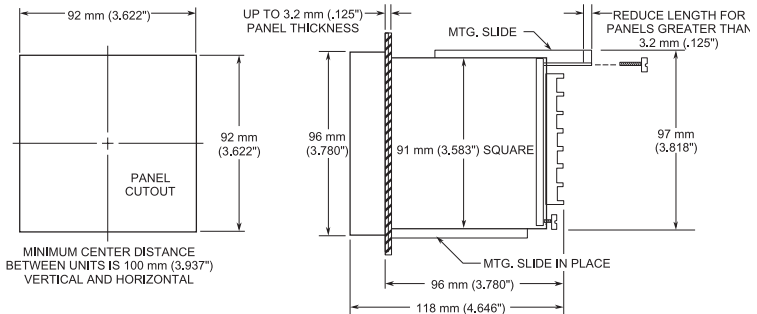


Figure 1: Cutout and case dimensions

## Power Wiring Circuits



**CAUTION**  
Possible fire hazard. Because these controls or associated equipment may not always fail safe, an approved temperature and/or pressure safety control should be used for safe operation.

Consult serial tag on the unit and select power wiring diagram for the model specified. All wires are connected to the terminals on the back of the case. Screw terminals are provided. Make appropriate connections using proper size wire for rated controller load power circuits. (On -B output model, use AWG #14 wire; for -F, -S and -T outputs use #14, 16, or 18 wire.) The unit can be supplied with 120 V or 240 Vac, 50/60 Hz. Select proper terminal for the voltage used.

### Typical Wiring Diagrams

#### -T & -B Outputs

B-Type - 840 W maximum. 120 Vac heater. (Non-inductive loads only) For larger loads, replace heater connections with contactor, as required. Maximum inductive load rating is 3 A at 120 V and 1.5 A at 240 V. The N.C. contacts can be used for cooling.

T-Type - solid state relay with SPST contacts. The -T units can handle contactors or resistive loads up to 1 A with 10 A inrush maximum. For -T units use a 1 A, 250 V fast blow fuse.

#### -L Output (Limit Controller)

Wiring can be similar to that shown for "B." The controller's relay is de-energized until the reset button on the front panel is momentarily pressed. The relay will energize if the sensor temperature is below setpoint. The common and N.C. terminals can be used to indicate alarm condition remotely when wired to lights, bell, etc.

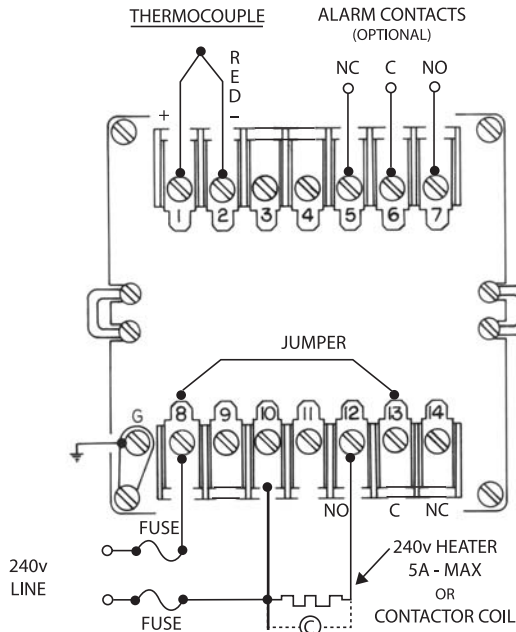


Figure 2a: Typical 240 Vac for -B & -T Output

Typical Wiring Diagrams

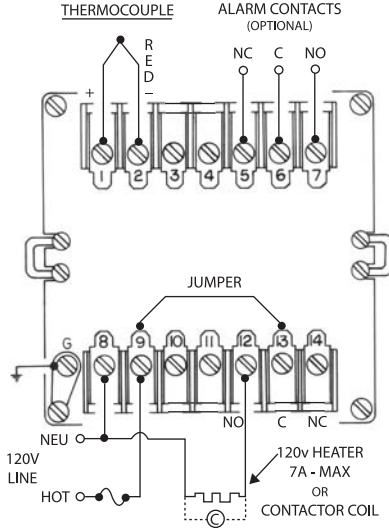
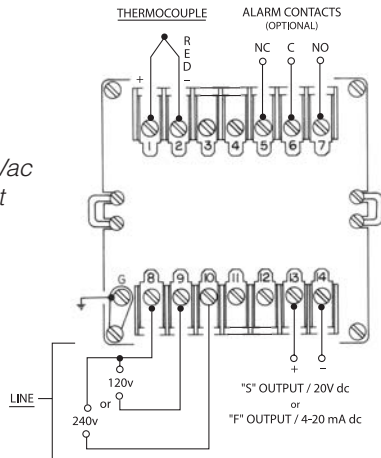


Figure 2b: Typical 120 Vac for -B & -T Output

-F, -S Output - 120/240 Vac

The -F output is 20 mA at the low temperature end of the proportional band and 4 mA at the upper end of the proportional band. Maximum load resistance is 1000 ohms. The -S output is a time-proportioned 20 Vdc signal. These controllers cannot be used with a device that does not have an isolated input. An ungrounded thermocouple must be used if there is ac leakage or a ground in the input of the device connected to the controller's output.

Figure 3: Typical 120/240 Vac for -F & -S Output



## Thermocouple Wiring Circuits

Use thermocouple and extension wire that conforms to the appropriate thermocouple type specified on the serial number tag. In thermocouple circuits, the negative lead is colored red. Extension wires must be of sufficient size so that on long runs the thermocouple circuit resistance does not exceed 100 ohms.

Do not run thermocouple leads in the same conduit as the power lines. If shielded thermocouple wire is used, terminate the shield only at the controller end using the corner screw provided for that purpose.

### Standard Thermocouples

I.S.A. Type (U.S.A.)	Materials	Color Code
J	Iron-Constantan (I/C)	White (+)/Red(-)
K	Chromel-Alumel (C/A)	Yellow (+)/Red (-)
T	Copper-Constantan	Blue (+)/Red (-)

## RTD Wiring Circuits

**NOTE: RTDs tend to be shock sensitive and require extra care in handling and installation**

The 2002 and 3220 units are designed for 100 ohm platinum RTDs. Two-wire RTDs are connected to terminals -1 and -2 with a jumper connecting 2 to 3. Keep leads short and use heavy gauge copper extension wires if necessary, to minimize lead resistance. For long runs 3-wire RTD should be used and wire gauge should be sufficient that resistance does not exceed 10 ohms.

#### **DO NOT RUN RTD LEADS IN THE SAME CONDUIT AS POWER LINES.**

If shielded RTD wire is used, terminate the shield only at the controller end, using the corner screw provided for that purpose.

## Thermocouple Placement

Proper thermocouple placement can eliminate many problems in the system. The probe should be placed so that it can detect any temperature change with little thermal lag. In a process that requires fairly constant heat output, the probe should be placed close to the heater. In processes where the heat demand is variable, the probe should be close to the work area. Some experimenting with probe location can often provide optimum results.

In a bath process, the addition of a stirrer will help to eliminate lags. Since the thermocouple is basically a point measuring device, putting more than one thermocouple in parallel will provide an average temperature reading and produce better results in air-heated processes.

The typical control system contains the sensor, controller (2000/3020) and the process (load). The sensor produces a small signal proportional to the measured temperature of the process. This signal is amplified by the controller, where it is compared with setpoint temperature. If the temperature of the sensor is below setpoint, the output circuitry will be actuated to apply power to the process. This is indicated by means of an LED light in the lower center of the front panel. The deviation meter will swing to the extreme left. It will remain there until the temperature of the probe rises to within 50 °F of setpoint, and then will continue to rise to the null point (zero degree deviation). The deviation meter accurately displays the difference between the probe's (process) temperature and the desired setpoint temperature.

### **-B - Relay Output**

The "B" output is a relay rated at 7 A, 120 Vac and 5 A, 240 Vac. These contacts can be wired to provide power to a heater within the above rating. A contactor can be operated to handle a larger load. Solenoids can be operated to control oil or gas heaters.

The controller operates as a narrow band controller when the band adjustment is set at the narrow position. As the band is widened, the unit becomes a time-proportioning controller, which provides close temperature control. The percentage of the time when the relay is energized is varied by the controller to meet the load requirements. Maximum cycle time setting is 15 seconds.

### **-F - Current Output**

Current proportional output of the -F unit is a 4 to 20 mA<sub>dc</sub> signal into 1000 ohm maximum. This output can be used to drive power controllers, motor positioners or electropneumatic actuators.

### **-S - Pulsed Voltage Output**

This output is similar to the -F output with the exception of a pulsed time base rather than a fully proportional current output signal. This output is designed to drive solid state contactors.

### **-L - Limit Control Output**

The -L output unit is designed as a high limit controller and is a variation of the -B output controller. The time proportioning circuit, along with the proportional band and offset (manual reset) adjustments, have been eliminated. A reset pushbutton has been added to the front panel and extends beyond the door. When power is applied, the controller will energize except for the output relay, which will operate after the reset button is pushed. The green LED indicates the safe or non-alarm condition. When the measured temperature exceeds the setpoint, the relay will de-energize and the green LED will turn off. Lights or horns can be driven directly, because the SPDT relay contacts are rated 7 A at 120 Vac or 5 A at 240 Vac.

### **-T - Solid State Output**

The -T output unit has a solid state relay with SPST contacts rated at 1 A, 120/240 Vac (10 A inrush maximum). These contacts can be wired to provide power to a heater within the above ratings, and a contactor can be added to handle larger loads. Solenoids can be operated to control oil or gas heaters.

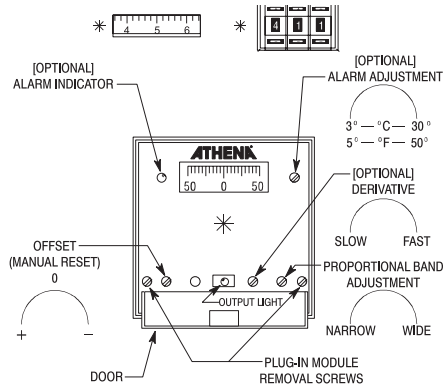
**NOTE:** To reach the plug-in module, push reset button while opening the door, and then remove two (2) screws.



## Front Panel Layout

Layout of the front panel is shown below. To reach the adjustments, swing the top of the door forward and down. The proportional band adjustment is on the right side and sets the gain of the controller. The offset (manual reset) adjustment is on the left and corrects for offsets from the setpoint temperature. The output indication (LED) can be seen through a window in the door.

Units ordered with Option A (3-Mode PID) will not have a manual reset adjustment. Instead, these units have an automatic rate adjustment on the front panel and an automatic reset selector switch inside the unit.



## Output Function Switches

### Output Function Switch Chart

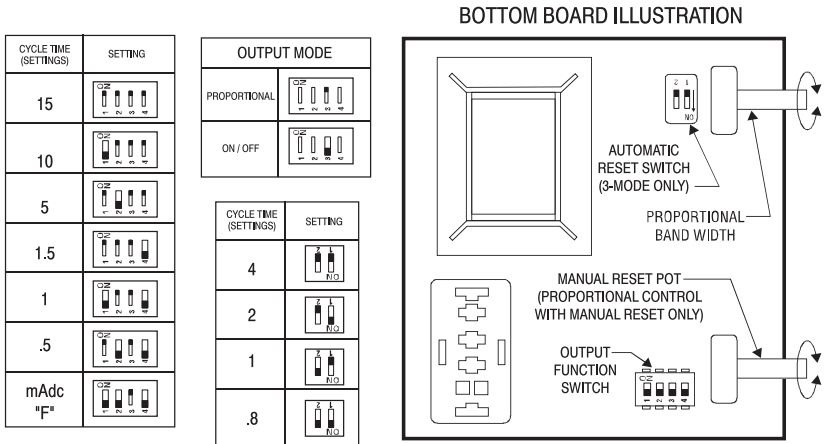


Figure 5: Output Function Switch Chart

NOTE:

—SWITCH NO. 4 IN “ON” POSITION IS FOR: “B” OR “T” OUTPUTS WHEN DRIVING MECHANICAL DEVICES, E.G., CONTACTORS.

—SWITCH NO. 4 IN “OFF” POSITION IS FOR “T”, “F”, OR “S” OUTPUTS WHEN DRIVING DEVICES THAT CAN WITHSTAND RAPID CYCLING, E.G., SOLID STATE DEVICES, SOLENOIDS, ETC.

## Output Function Switches

**NOTE:**  
Reconfigured or field-modified units should always be checked to assure that output switch positions are correct.

### How to Configure Output Function Switches

There is a switch assembly on the bottom board (see bottom board illustration). This four-position switch regulates cycle time and output selection. It is factory-configured for the plug-in output ordered. Check the output function chart to make sure the configuration is correct for your application. Figure 5.

Switches 1&2: These switches act together to select either proportional current output or one of the time proportioning cycle times. (See the output function switch chart.) Use longest times to get best relay life expectancy. If meter shows temperature swings following each “on” cycle, select a faster time to reduce “ripple.”

Switch 3: Selects either on/off or proportional action. “On” provides proportional action. “Off” provides on/off action.

Switch 4: Selects output for either mechanical or solid state relays.

On: Provides slow proportional times for mechanical relays

Off: Provides 20 mAdc when used with the “F” module or fast time proportioning times when used with “S” or “T” modules.

NOTE: Switch 4 changes the cycle times in conjunction with switches 1 and 2. Check output function switch chart.

## Adjustments

### Proportional Band Adjustments for All Outputs

The proportional band adjustment widens or narrows the band over which proportional action occurs. Too narrow a band can cause the temperature to swing about the setpoint. This can be seen on the deviation meter. Too wide a band can cause an error between the setpoint and the actual temperature (droop error) as measured at the sensor.

Proper setting of this adjustment is the point where the temperature swings just stop. When adjusting the proportional band control, do so in small increments, allowing time between each adjustment for the process to stabilize.

Turning the adjustment in a clockwise direction widens the proportional band and should reduce swings to straight line control with most processes.

### Offset (Manual Reset)

After the proportional band is set, the process temperature may stabilize at a point other than the setpoint, high or low, as shown on the deviation meter. This can be corrected with the offset (manual reset) adjustment. If the deviation meter indicates a low temperature, turn the offset (manual reset) adjustment clockwise (+ direction) until the deviation meter is at zero. Turn the offset (manual reset) adjustment counter-clock-

## Adjustments

wise (- direction) for high temperature as indicated by the deviation meter.

NOTE: If close control cannot be obtained after carefully repeating the above procedures, check to see if the thermocouple probe is in good contact with the heated process, and if the heaters are correctly sized for the application. Applications involving large changes in setpoint operating temperature, or large load changes, will require readjustment of the proportional band and offset (manual reset) pots.

### How to Set the Alarm

Deviation alarms are triggered when the temperature deviates from the setpoint by a predetermined amount. Units can be ordered with either high, low, or high/low alarms.

1. Turn the adjustment clockwise to widen the span between the process setpoint and the alarm, or counterclockwise to narrow it. (Full clockwise should be about 50 °F (30 °C) from setpoint. Full counterclockwise should be only 5 °F (3 °C) from setpoint.
2. To check the actual alarm point, simply change the setpoint until the deviation meter reads zero. Then move it downward (for high alarm) or upward (for low alarm). When the alarm is triggered, check the deviation meter -- it will show deviation in the amount you've set on the alarm.

### Optional 3-Mode (PID)

How to Set Reset, Proportional Band, and Rate

Auto reset action automatically, but slowly, corrects droop error in proportionally controlled processes. Ideal reset time is one half the period of oscillation of the process. Slower settings are safe, but sluggish. Faster settings will cause continuous oscillation.

1. For slow processes, move switches 1 and 2 off, set rate slow, proportional band wide, and go to Step 4. Otherwise:
2. **Set reset time** (internal switches are indicated on automatic reset switch chart below). Use the fastest time (0.8 minutes) for very fast processes, 1 minute for most others, as a first try.
3. **Set the proportional band to full wide** (270° clockwise). Make sure rate is full fast, turned full clockwise, as well.)
4. **Plug** controller in, turn your process on.
5. **Observe warm-up.** If the process overshoots setpoint and cycles in continually decreasing waves

## Adjustments

**NOTE:** *Each process will tolerate differing warm-up curves. Often, a fast warm-up is more important than the elimination of overshoot. If it is important to eliminate overshoot, a slower setting should be used, but it will also add to the time it takes the process to reach the setpoint.*

*In general, it is best to maintain the tightest parameters possible (narrow proportional band, faster reset, faster rate) that still deliver optimal process response.*

until it finally stabilizes, the reset time is correct. Then proceed to Step 7. If it continues to oscillate, reset it to short, continue with Step 6.

6. **Set reset switches to the next slowest time.** Repeat Step 5. Continue changing settings until the process stabilizes.
7. **Turn proportional band pot 1/4 turn toward narrow** (counterclockwise). Process could begin to oscillate again. If it doesn't, proceed to step 8. If it oscillates, back up 1/8 turn clockwise.
8. **Tighten proportional band by turning the pot counterclockwise.** Observe the process. If oscillation continues, widen back by 1/8 turn. Continue until the process stabilizes.
9. **Set the rate.** Rate action responds to sudden load changes and anticipates power output requirements. It also helps to eliminate overshoot on start-up. Rate should be approximately 1/6 of reset time. If the reset time is 0.8 minutes, the rate should be turned clockwise. For 1 minute, mid-position. For 2 minutes, it should be at least 3/4 full; for 4 minutes full slow.
10. **Turn the process off to cool, then start up again observing the warm-up curve.** If it takes the process too long to reach the setpoint, make the rate faster by turning it back clockwise. If, on the other hand, it overshoots the setpoint by an amount that is not acceptable, slow the rate by turning the pot counterclockwise.
11. **Fine tuning.** If, after having established parameters, you'd like to improve response, it can be accomplished by a simple "trial and observation" technique.
  - A. Change a parameter (either rate or proportional band) by a significant value (the pots generally need to be moved 30° to produce an effect).
  - B. Change the setpoint.
  - C. Observe the way the process responds -- if response is improved (i.e., faster rise, less overshoots, faster stabilization at setpoint), retain the new value. If not, return the old value.
  - D. Try another parameter.

Some preventive maintenance steps on the controllers are:

1. Keep the controller fairly clean, and protect it from dirt, oil, and corrosion. An optional dust cover is available for use in hostile environments.
2. Periodically recheck all electrical connections.

## Maintenance

### CAUTION:

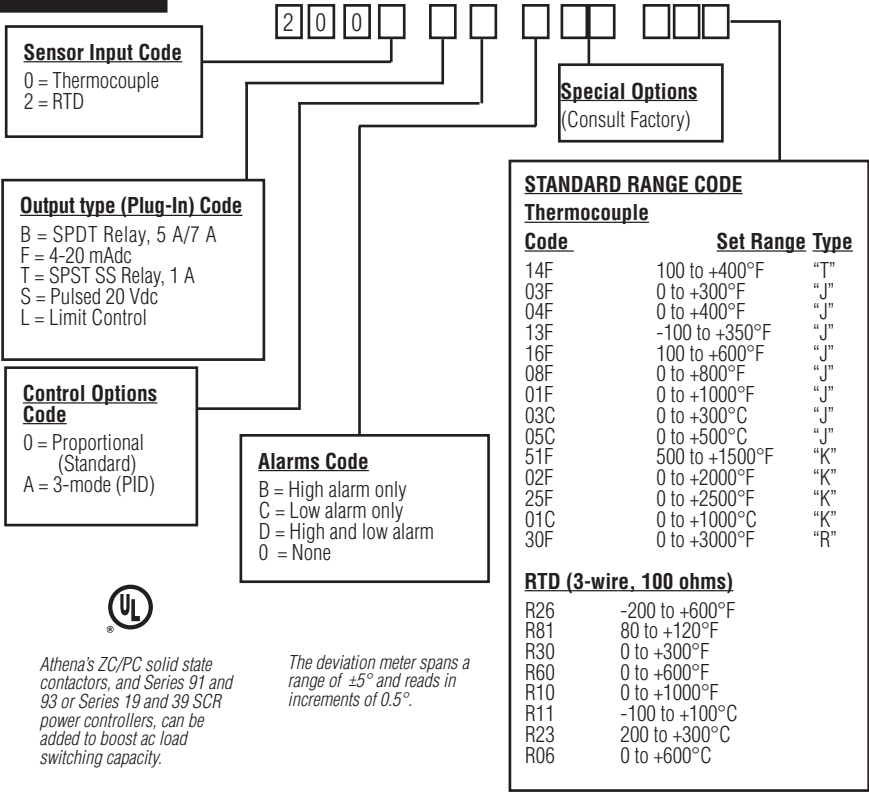
Since the front panel and the meter face are plastic, do not use solvents to clean them.

# Specifications

<b>Supply Voltage:</b>	120/240 Vac, +10% -15%, 50/60 Hz
<b>Setpoints:</b>	<i>Series 2000:</i> Analog - single-turn potentiometer, 270° rotation <i>Series 3020:</i> Mechanical digital potentiometer
<b>Setpoint Repeatability:</b>	+/-0.3% of span (Series 2000)
<b>Setpoint Resolution:</b>	<i>Series 2000:</i> 0.2% of span <i>Series 3020:</i> 1 °F or °C
<b>Input:</b>	Thermocouple Types J, K, T, R (Series 2000)Types J, K (Series 3020), range dependent. Maximum lead resistance 100 ohms for rated accuracy; cold junction compensation standard. RTD input 100 ohms platinum at 0°C, DIN (.00385) curve.
<b>Thermocouple</b>	
<b>Break Protection:</b>	Built-in, failsafe, open sensor, output zero; Meter units – upscale indication
<b>Cold Junction Compensation:</b>	
<b>Accuracy:</b>	Automatic electrical +0.5% of span at calibration points
<b>Indication, Temperature:</b>	Deviation meter +50 °F (+30 °C) of setpoint
<b>Load:</b>	LED on when power is supplied to load
<b>Proportional Band:</b>	On/off or nominal 5 °F - 50 °F (3 °C - 30 °C)
<b>Offset (Manual Reset):</b>	Adjustable over 100% of proportional band
<b>Rate (Derivative):</b>	0.5 to 25 seconds
<b>Reset (Integral):</b>	0.7, 1, 2 or 4 minutes via internal DIP switches
<b>Alarm:</b>	3 A at 120 Vac
<b>Output:</b>	B - SPDT Relay, non-inductive rated 7A/5A max at 120/240 Vac, 50 VA inductive F - 4 to 20 mAdc into 1000 ohms max load L - SPDT Relay, non-inductive rated 7A/5A max at 120/240 Vac, 50 VA inductive S - 20 Vdc into 1000 ohm maximum load T - 1 A solid-state relay; 10 A max. inrush
<b>Ambient Temp Range:</b>	30° to 130 °F (0 to 55° C)
<b>Weight:</b>	1 lb, 9 oz (709 g)

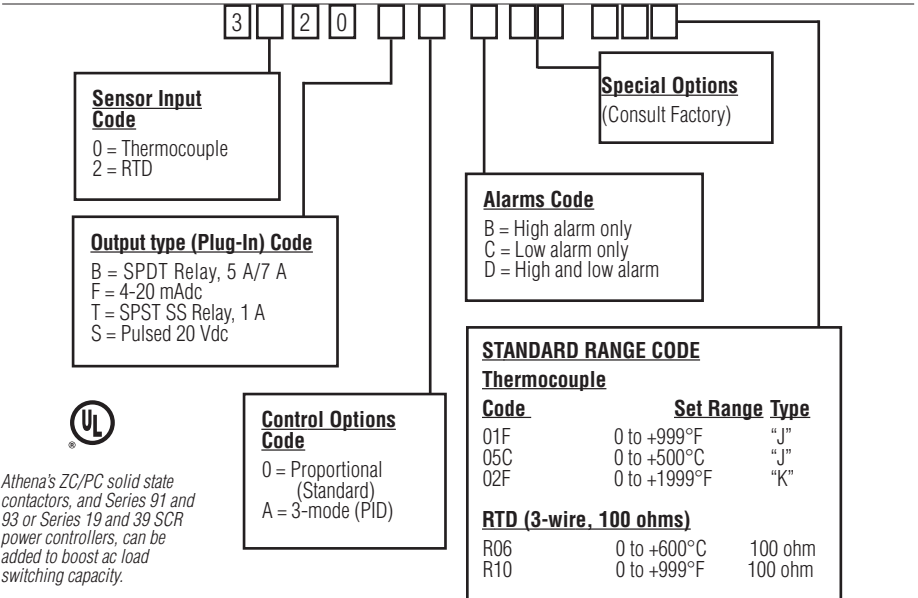
*All specifications subject to change.*

# Ordering Codes



Athena's ZC/PC solid state contactors, and Series 91 and 93 or Series 19 and 39 SCR power controllers, can be added to boost ac load switching capacity.

The deviation meter spans a range of  $\pm 5^\circ$  and reads in increments of  $0.5^\circ$ .



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# Troubleshooting

## Symptom

Controller dead. No output light, no meter deflection

## Probable Cause

- No line voltage input
- Open PC board to backplate connector (defective connector)
- Open power transformer

## Check

Verify 120/240 Vac, 50/60 Hz input voltage. Check heater for shorts. Look for open breakers or open external fuse. Remove input power. Check continuity through power transformer primary. With ohmmeter, read between pins: 8 and 9 for 225 or 450 ohms +/-10% and 8 and 10 for 680 or 1000 ohms +/-10%

## Corrective Action

- Replace heater, if shorted
- Restore power
- Replace either power transformer or backplate connector

## Symptom

No output, step 1 ok, meter nulls at ambient

## Probable Cause

- External backplate jumper missing (all models except "S" and "F")
- Defective relay
- Open heater or heater circuit wiring

## Check

If no readings in either step above, remove controller from housing and repeat resistance measurements as above, but directly on PC board lands corresponding to pins 8, 9, and 10. Correct readings indicate open PC board to backplate connector problem. Incorrect readings indicate power transformer problems. Visually inspect relay contacts. Heater continuity and wiring.

## Corrective Action

- Install jumper
- Replace relay if contacts are worn or dirty
- Replace open heater, correct defective wiring

## Symptom

No output, meter reads full scale positive, no heat

## Probable Cause

- Open thermocouple or T/C wiring

## Check

T/C continuity. Disconnect T/C connections from instrument. Measure T/C circuit resistance. Ohmmeter should read 100 ohms or less.

## Corrective Action

- Replace T/C. Correct defective wiring

## Symptom

Full output, no control. Output light stays on.

## Probable Cause

- Thermocouple connections reversed
- T/C lead wires shorted between T/C and control

## Check

Connection polarity. T/C wires are color-coded. Red is the negative (-) lead. (for U.S.A.) T/C lead wiring.

## Corrective Action

- Connect correctly
- Repair or replace

## Symptom

Full output, no control. Output light goes off. Meter goes upscale.

## Probable Cause

- Relay contacts welded closed

## Check

Disconnect power and load. Measure resistance between pins 12 and 13. Should read infinity.

## Corrective Action

- If resistance reading is near 0 ohms, replace relay

## Troubleshooting

### Symptom

Process control temperature differs from setpoint when read with an external pyrometer. Deviation meter nulls and process is stable.

### Probable Cause

- T/C lead wires shorted close to process
- Wrong type of T/C being used, etc.
- Standard electrical wiring being used in place of T/C wire
- Gradient error

### Check

Check T/C lead wires at back of probe  
Wire color indicates type of T/C  
Verify type of wire

### Corrective Action

- Replace defective wiring
- Install correct T/C for temperature range of instrument. See instrument serial number tag for T/C type.
- Run only T/C wire between process and controller.
- Use electronic indicator in parallel with suspect instrument's T/C input.

### Symptom

Temperature overshoots, or oscillates.

### Probable Cause

- Process overpowered
- Bandwidth too narrow
- Process or sensor lag

### Check

Check bandwidth  
Loose heater or sensor fit. Poor relative location.

### Corrective Action

- Reduce total heater power
- Widen band
- Improve fit, locate closer together

### Symptom

Process control temperature stabilizes above or below setpoint as read on deviation meter.

### Probable Cause

- Offset (manual reset) incorrectly adjusted
- Partial short to ground in heater when used on 240 V line
- No output from suspect control
- Controller reading other zones of multi-controlled process
- Full output from suspect control
- Apparent stabilization from other zones of multi-controlled process
- Improperly sized heater

### Check

Offset (manual reset)  
Heater to ground resistance  
Design parameters for process heat required

### Corrective Action

- Adjust (+) to increase controlled temp. (-) to decrease temp.
- Replace defective heater

*NOTE: Fuse blowing is not caused by the controller. Blown fuses are caused by shorts in the heater circuit, and must be corrected to prevent damage to the controller.*



# Warranty

## Two-Year Limited Warranty

THIS EQUIPMENT IS WARRANTED TO BE FREE FROM DEFECTS OF MATERIAL AND WORKMANSHIP. IT IS SOLD SUBJECT TO OUR MUTUAL AGREEMENT THAT THE LIABILITY OF ATHENA CONTROLS, INCORPORATED IS TO REPLACE OR REPAIR THIS EQUIPMENT AT ITS FACTORY, PROVIDED THAT IT IS RETURNED WITH TRANSPORTATION PREPAID WITHIN TWO (2) YEARS OF ITS PURCHASE.

THE PURCHASER AGREES THAT ATHENA CONTROLS, INCORPORATED ASSUMES NO LIABILITY UNDER ANY CIRCUMSTANCES FOR CONSEQUENTIAL DAMAGES RESULTING FROM ITS USE OR FROM IMPROPER HANDLING OR PACKAGING OF SHIPMENTS RETURNED TO THE FACTORY.

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THE SPECIFICATIONS PUT FORTH IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE.

### Unit Repairs

It is recommended that units requiring service be returned to an authorized service center. Before a controller is returned for service, please consult the service center nearest you. In many cases, the problem can be cleared up over the telephone. When the unit needs to be returned, the service center will ask for a detailed explanation of problems encountered and a Purchase Order to cover any charge. This information should also be put in the box with the unit. This should expedite return of the unit to you.

This document is based on information available at the time of its publication. While efforts have been made to render accuracy to its content, the information contained herein does not purport to cover all details or variations in hardware, nor to provide for every possible contingency in connection with the installation and maintenance. Features may be described herein which are not present in all hardware. Athena Controls assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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